

WHAT IS CLAIMED IS:

1. A heat treatment process for restoring the properties of an aircraft engine article having an Inconel 718 cast portion and a forged portion that has been subjected to repeated thermal cycles below the  $\delta$  solvus comprising the steps of:

providing an Inconel 718 article to be treated;

heating the article in a non-oxidative atmosphere, at a rate to minimize distortion of the article, to a temperature in a range of about 1950°F to about 2150°F;

holding the article at a temperature in the range of about 1950°F to about 2150°F for a time sufficient to fully solution precipitates;

cooling the article to a temperature in the range of about 1000°F to about 1200°F in a protective atmosphere at a rate sufficient to maintain dimensional stability while avoiding the formation of  $\delta$  phase;

cooling the article to room temperature; and

removing the forged portion of the article.

2. The process as in claim 1, wherein the step of heating further includes a non-oxidative atmosphere is a vacuum having a pressure of about 0.5 micron.

3. The process as in claim 1, wherein the step of heating the article at a rate to minimize distortion includes the following steps:

heating the article to a temperature in a range of about 975°F to about 1025°F; then

stabilizing the temperature of the article in the range of about 975°F to about 1025°F; then

within 60 minutes of stabilizing the part, heating the part to a second temperature in the range of about 1950°F to about 2150°F;

4. The process as in claim 1, wherein the process includes welding the treated cast Inconel 718 article to new wrought Inconel 718 portion after the cooling step, to yield a repaired article.

5. The process as in claim 4, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1350°F to about 1450°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1100°F to about 1200°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.
6. The process as in claim 5, wherein the first preselected period is about one hour, the second preselected period is about eight hours, and the third preselected period is about four hours.
7. The process as in claim 1, wherein the process includes welding, after the cooling step, the treated cast Inconel 718 article to a wrought article, wherein the wrought article is an alloy selected from the group consisting of Waspaloy and Rene 41, to yield a repaired article.
8. The process as in claim 7, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1250°F to about 1350°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1150°F to about 1250°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.
9. The process as in claim 8, wherein the first preselected period is about one hour, the second preselected period is about eight hours, and the third preselected period is about one hour.

10. The process as in claim 1, wherein the process includes welding the treated cast Inconel 718 article to a wrought Incoloy 903 article after the cooling step, to yield a repaired article.
11. The process as in claim 7, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1250°F to about 1350°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1100°F to about 1200°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.
12. The process as in claim 11, wherein the first preselected period is about one hour, the second preselected period is about eight hours, and the third preselected period is about eight hours.
13. The process as in claim 12, wherein the process includes welding the treated cast Inconel 718 article to a wrought Incoloy 907 article after the cooling step, to yield a repaired article.
14. The process as in claim 13, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1400°F to about 1525°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1100°F to about 1200°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.
15. The process as in claim 14, wherein the first preselected period is about one hour, the second preselected period is about sixteen hours, and the third preselected period is about eight hours.

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16. The process as in claim 1, wherein the process includes welding the treated cast Inconel 718 article to a wrought Incoloy 909 article after the cooling step, to yield a repaired article.
17. The process as in claim 16, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1350°F to about 1450°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1100°F to about 1225°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.
18. The process as in claim 17, wherein the first preselected period is about one hour, the second preselected period is about eight hours, and the third preselected period is about four hours.
19. An aircraft engine frame comprising a cast Inconel 718 portion and a wrought Inconel 718 portion treated with the process of step 1.
20. A aircraft engine frame comprising a cast Inconel 718 portion and a wrought Waspaloy portion treated with the process of step 1.

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